FOM-Institute for Plasma Physics Rijnhuizen

# EUV metrology tools for position sensitive detection and broadband spectroscopy

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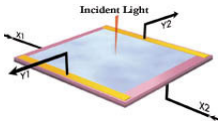
## Position Sensitive Detector for EUV (PSD)

- Developed to monitor EUV beam or spot position and stability
- PSD consists of two contacts placed across active surface
- Surface functions as a homogenous resistance
- Position in the *x* direction is obtained by:

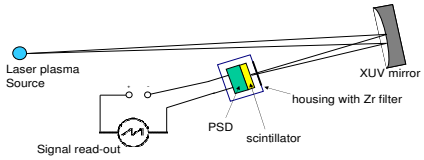



$$x = \frac{\text{sensor length}}{2}\left(\frac{X1 - X2}{X1 + X2}\right)$$

- 2D PSD enables simultaneous measurement of X and Y position
- additional use for measurement of light intensity

## Test geometry

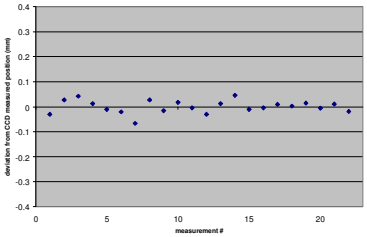
Set-up for monitoring EUV component of plasma emission
Signal read-out by measuring current (continuous source) or charge (pulsed source)




- focusing multilayer mirror optimized for 13.5nm
- Zr filter, suppressing out-of-band radiation
- scintillator material, sensitive for EUV
- PSD (Position Sensitive Detector)

## EUV spot position sensing

Comparison of PSD test lay-out and pinhole CCD imaging system

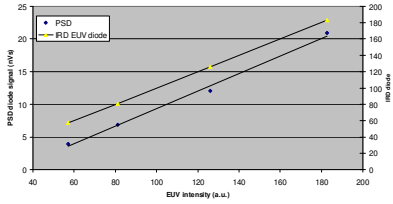



- Data shows difference between the position measured by CCD and PSD
- Inherent source jitter used to generate random position data

✓ ***Positional accuracy ≤ 66µm over 4x4mm sensor size***

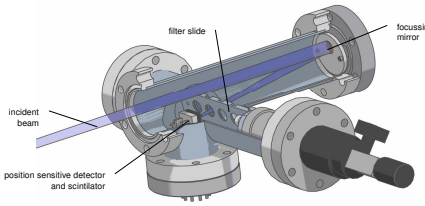
## EUV spot intensity measurement

Simultaneous usage as EUV power monitor




- PSD+YAG combination is linear within chosen range
- PSD shows off-set due to recombination effects

✓ ***Set-up shows that additional data on relative intensity can be obtained***



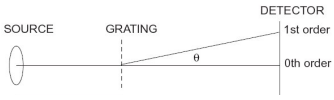

✓ Compact design (same geometry as Flying Circus')

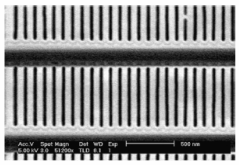
✓ Reduced cost compared to CCD

✓ Additional possibility to monitor relative source intensity

## EUV Transmission Grating Spectrometer (TGS)

- Recording of both in-band EUV and out-of-band radiation (simultaneously)
- Components
  transmission grating (100 nm and 1500 nm period)
  filter slide and back-illuminated CCD detector
  PTB-calibrated filters

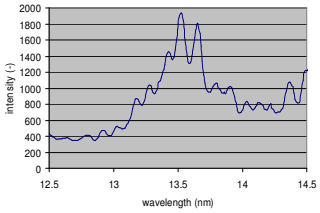


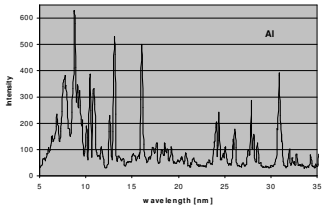
*SEM Image of transmission grating, showing the slit structure and the support bars*

- Experimental LPP calibration source (FOM)
  - Nd:YAG laser ~0.5J, solid Sn and Al target materials
- Spectra up to 35 nm wavelength
- Mode selection by changing distance between grating and detector

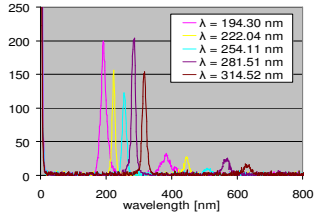
## EUV & UV/VIS Spectra




*Detail of hi-res XUV (res. 0.1nm) spectrum (Xe)*




*Detail of broad band XUV (res. 0.5nm) spectrum of Al plasma (FOM, LPP 0.5J)*



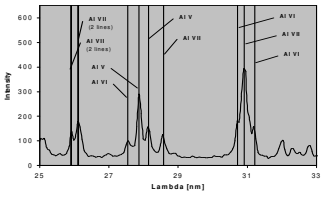

*UV/VIS calibration data of Sn plasma (FOM, LPP 0.5J)*

- 5 spectra using 5 band pass filters
- Designed structure is optimized to suppress second and higher even orders

✓ ***EUV range: 0.1 nm resolution in high res mode, 0.5 nm in broad-band mode***
✓ ***Simultaneous recording of spectra from 120 nm to 900 nm at <5 nm resolution***

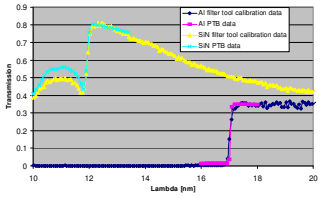
## Spectrometer Calibration

Example of calibrated line spectrum (Al)




*Detail of broad band XUV spectrum of Al LPP plasma*

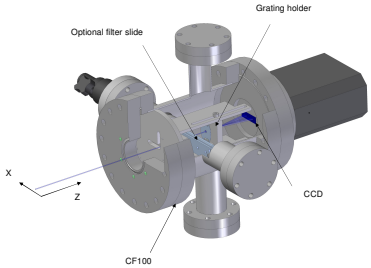
Wavelength calibration by using filters with pre-calibrated transmission characteristics




*Calibration spectrum by using absorption edges of pre-calibrated thin filters.*

## Compact transmission grating spectrometer

- *Spin-off result of research FOM*
- *Commercially available through Scientec www.scientec.nl (info@scientec.nl)*




✓ Resolution down to 0.1 nm at 13nm
✓ Deliverable with gratings with period 100 nm to 250 nm (range 40 nm resp. 100 nm)
✓ Support bars from grating used to record broadband spectra up to the visible range

•Grating movement in X dir up to 18mm
•Grating to CCD distance can be set from 25 to 100 mm (from broad-band to hi-res mode)
•Optional filter slide for up to 4 filters
•Special versions engineered upon request

## Acknowledgements

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